

NCR

**Competitive Disk/Tape  
Customer Satisfaction Study**

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## **I. Introduction**

### **A. Objectives**

The objectives of this study are to determine the current performance of specific IBM and DEC tape and disk products and to determine user expectations regarding performance. The key areas of performance evaluated are reliability and availability. In addition, user satisfaction with reliability, availability and the overall product is examined.

### **B. Methodology**

Information was gathered for this study by a structured telephone interview. A questionnaire was developed and tested on a small group of respondents to determine if the users seemed to understand the questions and if their responses appeared to be reasonable. The conclusion was that the questionnaire was satisfactory and no changes were necessary. A copy of the questionnaire is in Appendix A.

Appendix B contains a list of the definitions of key terms used in this study. Interviews were conducted with 355 users of 11 different DEC and IBM tape and disk products. IBM 3380 users were required to have a minimum of 10 drives to be a respondent. No minimum was required for other products.

INPUT surveyors contacted the appropriate data processing official, and in most cases the respondents were managers or technical people with titles such as Data Processing Manager, (Computer) Operations Manager, Systems Engineer, etc. Each interview lasted approximately 20 minutes.

Actual reliability is presented in terms of a calculated mean time between failures (MTBF) and in terms of the number of service calls per device/year. Appendix C contains the formulas used for these items. The calculation is necessary to properly consider respondents who have zero failures and to properly weight responses by the number of drives. In addition, the number of systems interruptions/respondent/year and the percent due to tape or disk are calculated and presented.

The actual number of service calls/respondent the past year (total and routine calls) were adjusted in cases of partial year installed and divided by the number of machines installed to obtain calls/year/machine.

Expected reliability is presented in terms of expected MTBF as reported by the users.



Actual availability percentage is presented in terms of a calculated customer expected usage time less response, repair and recovery time divided by the calculated customer expected usage time. The formula for this calculation is presented in Appendix D.

Actual availability is also presented in terms of up-time as reported by the users. Up-time is defined as time when maintenance is not being performed or when the disk/tape device is operating.

Expected availability is presented in terms of expected up-time as reported by the user.

## **C. Sample Characteristics**

### **1. Product**

Exhibit I-1 shows the number of interviews conducted with 355 users of 11 different DEC and IBM tape and disk products. We started out with a sample size of 30 so that standard normal distribution can be used to make the statistical estimates of confidence levels.

### **2. Business Sector**

The 355 sample interviews were distributed across all business sectors as shown in Exhibit I-2. The largest percentage of respondents were in the manufacturing sector and the smallest were in transportation, utilities, federal and consumer/home sectors.

### **3. Average Hours per Day in Use**

Overall, the DEC disk products, as shown in Exhibit I-3, running over two shifts per day had higher usage than the IBM disks. However, the IBM 3380 disk products had the highest usage per day, with 23.6 average hours per day.

The IBM 3480 tape product had the highest average hours per day usage, with 20.5 hours. The remaining IBM and DEC tape products were used less than one shift per day.

### **4. Average Days per Week in Use**

Exhibit I-4 shows the DEC disk products being used more than six days per week. The IBM 9347 tape product utilization was the smallest, with 5.1 days per week.



## 5. Age by Product

Exhibit I-5 shows the average age of the disk and tape products that was calculated from Question 4a. The IBM AS/400-20 disk was installed the shortest period of time, while the IBM 3380 disk the longest.

## 6. Applications per Product

- Fifty-seven percent of the IBM disks and 34% of the DEC disks were used to run more than one application.
- Forty-eight percent of the IBM tapes and 16% of the DEC tapes were used to run more than one application.
- IBM devices were used to run all the applications mentioned in Question 3.
- DEC devices were used to run all but the following applications:
  - Transportation
  - Utilities
  - Distribution
- The following applications had the highest number of products being used:

<u>Application</u>	<u>Total Number of Mentions (by Subsystem)</u>
Accounting (AR, AP, GL)	159
Office Systems (Word Processing, E-Mail, Calendar, etc.	82
Engineering/Scientific	61
Manufacturing	59
Banking/Finance	29
Schools	28

All the other applications had 19 or less mentions by product.

- The following is the total number of mentions of IBM/DEC disk and tape products for the above applications:

	<u>Disk</u>	DEC <u>Tape</u>	<u>Disk</u>	IBM <u>Tape</u>
Accounting	20	5	84	50
Office Systems	20	3	39	20
Engineering/Scientific	39	6	11	5
Manufacturing	15	3	27	14
Banking/Finance	7	1	9	12
Schools	12	2	7	7

#### 7. Percent Popular CPU Mentioned

Exhibit I-6 shows for each IBM and DEC disk and tape product the percent that was installed by CPU type.

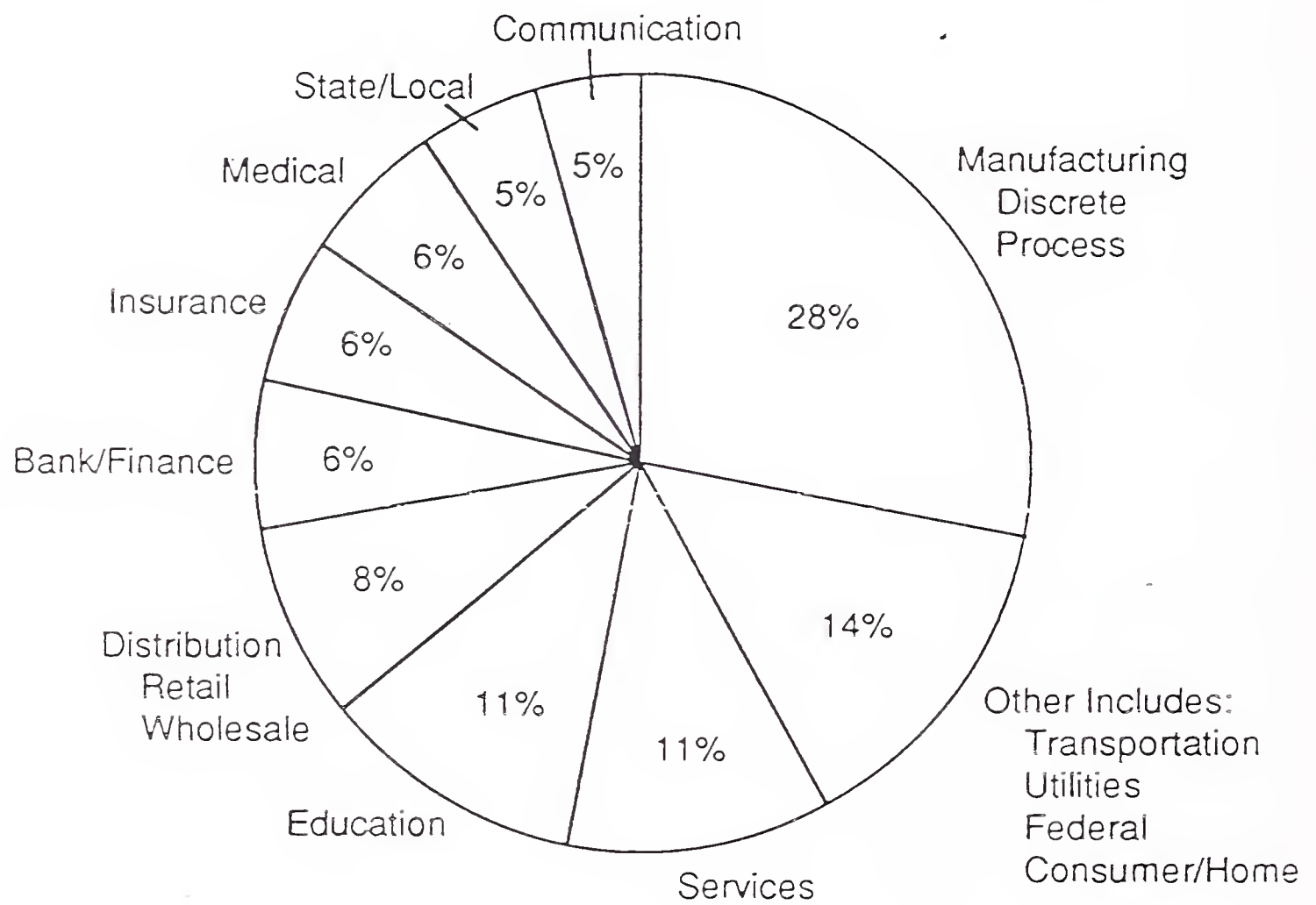
# EXHIBIT I-1

## SAMPLE BY PRODUCT

<u>Product</u>	<u>Total Number of Interviews</u>
<u>Disk</u>	
IBM 3380	38
9332	30
9335	31
AS/400-20	30
DEC RA82	34
SA482	32
RA70	33
<u>Tape</u>	
IBM 3422	30
9347	30
3480	35
DEC TU81	32
TOTAL	355

## EXHIBIT I-2

### SAMPLE DISTRIBUTION BY BUSINESS SECTOR



Sample Size: 355

EXHIBIT I-3  
AVERAGE HOURS PER DAY IN USE

		<u>Av. Hrs. per Day</u>	<u>Std. Error of Mean</u>
<u>Disk</u>			
IBM	3380	23.6	0.257
	9332	15.7	1.420
	9335	17.6	1.240
	AS/400-20	13.5	1.350
DEC	RA 82	20.4	1.030
	SA 482	22.9	0.595
	RA 70	19.4	1.210
<u>Tape</u>			
IBM	3422	6.2	1.300
	9347	6.0	1.515
	3480	20.5	1.197
DEC	TU 81	7.1	1.500

EXHIBIT I-4  
AVERAGE DAYS PER WEEK IN USE

		<u>Av. Days Per Week</u>	<u>Std. Error of Mean</u>
<u>Disk</u>			
IBM	3380	6.5	0.129
	9332	5.8	0.175
	9335	6.0	0.150
	AS/400-20	5.7	0.219
DEC	RA 82	6.4	0.152
	SA 482	6.8	0.083
	RA 70	6.5	0.144
<u>Tape</u>			
IBM	3422	5.2	0.169
	9347	5.1	0.216
	3480	6.4	0.148
DEC	TU 81	5.7	0.250



EXHIBIT I-5  
AGE BY PRODUCT  
(in Years)

		<u>Mean</u>	<u>Median</u>	<u>Range</u>	<u>Error of Mean</u>	<u>Number Responding</u>
<u>Disk</u>						
IBM	3380	3.3	3.00	0.84 - 8.00	0.28	33
	9332	1.5	1.22	0.17 - 5.00	0.21	30
	9335	1.2	1.50	0.33 - 2.00	0.10	31
	AS/400-20	0.5	0.50	0.17 - 0.75	0.03	30
DEC	RA 82	1.8	1.73	0.63 - 5.00	0.17	34
	SA 482	1.7	1.50	1.00 - 3.00	0.12	32
	RA 70	0.7	0.54	0.22 - 1.33	0.05	32
<u>Tape</u>						
IBM	3422	2.0	2.00	0.50 - 5.00	0.20	29
	9347	1.2	0.75	0.30 - 5.00	0.22	29
	3480	2.3	2.00	0.75 - 5.00	0.19	30
DEC	TU 81	2.2	2.00	0.50 - 5.00	0.20	30

**EXHIBIT I-6**  
**PERCENT POPULAR CPU MENTIONED**  
**(by Product)**

	<u>3090</u>	<u>308X</u>	<u>4381</u>	<u>937X</u>	<u>4700</u>	<u>S/38</u>	<u>S/36</u>	<u>AS/400</u>	<u>Others</u>
<u>IBM/Disk</u>									
3380	31	33	27						9
9332						16	37	37	10
9335				31		34		31	4
AS/400-20								100	

<u>IBM/Tape</u>									
3422			21		10	41			28
9347				34				50	16
3480	43	9	37						11

	<u>11/7XX</u>	<u>6220</u>	<u>11</u>	<u>3XXX</u>	<u>8250</u>	<u>8350</u>	<u>85XX</u>	<u>86XX</u>	<u>8700</u>	<u>88XX</u>	<u>Others</u>
<u>DEC/Disk</u>											
RA82	20	6	7	14		6	20	10			17
SA482	12	6					8	21	17	19	17
RA70				86							

<u>DEC/Tape</u>											
TU81	28				22	7	20				23

## **II Executive Summary**

INPUT was selected to conduct a study for NCR to determine reliability and availability information on specific IBM and DEC tape and disk products. Specifically, NCR needs to compare Mean Time Between Failure and Calls per Machine per Year between NCR tape and disk products and similar products from IBM and DEC

NCR has collected similar information on NCR products through customer visits and intends to use this data in conjunction with the data from this study to make the comparison.

Three hundred fifty-five telephone interviews were conducted with users of 11 IBM and DEC tape and disk products. Thirty or more interviews were conducted in each product category. The questionnaire used in the survey is included as Appendix A of this report.

In terms of hours and days of use, the most heavily used disk products were the IBM 3380 and the DEC SA482. The most heavily used tape products, by a factor of almost 300%, was the IBM 3480 drive.

The machines with the highest number of machine months installed in the sample was the IBM 3380 disk drive and the IBM 3480 tape drive. The IBM AS/400-20 disk drive had the shortest number of installed months and therefore the least amount of customer experience with the product.

In the IBM disk environment, the major customer applications were found to be Accounting, Office Systems, and Manufacturing. The DEC disk environment primarily supported Engineering/Scientific, Accounting, and Office Systems.

In the IBM tape environment, the key applications were Accounting and Office Systems while in the DEC tape environment, there was no major application area.

### **A. Product Reliability**

#### **1. Calculated Mean Time Between Failures**

Exhibit II-1 displays a summary of the Calculated Mean Time Between Failure data for the sample products studied. INPUT used a consistent approach across all products and adjusted the data for the number of products installed, the average time installed, and the customer product usage hours.

A good indicator of the high reliability of these products is the percent of respondents who reported no failures on their disk or tape subsystem.

For disks, the IBM 3380 is clearly the leader, with a calculated MTBF of 91.82 months. The DEC SA482 has the lowest MTBF (i.e., 15.86 months). In the tape drive area, the IBM 3480 leads with a MTBF of 17.84 months and the IBM 9347 has the lowest MTBF for tapes (i.e., 1.42 months).

## **2. Disk/Tape Drive Maintenance Calls Non-Routine/Routine per Machine Over the Last Year**

Service or maintenance calls per machine over the past year is another way to define reliability. The number of maintenance calls, separated into non-routine and those that were routine maintenance is displayed in Exhibit II-2 for disk drives and Exhibit II-3 for tape drives.

The IBM 3380 disk drive clearly is a leader in this area, while the IBM AS/400-20 appears to be in trouble. There is an average age of only 0.5 years on this product however, so the confidence in the data is questionable.

The IBM 3480 tape drive is a leader, while the IBM 9347 has a very high number of calls reported.

User satisfaction data with product reliability was also measured, and the IBM 3380 leads other products by a wide margin for disks, and the IBM 3422 and IBM 3480 lead the tape drive products.

## **B. Product Availability**

System Availability with the latest products typically runs 96% or higher for small systems and 98% or higher for large systems. The availability of the units that make up the system therefore have a requirement for a much higher availability unless they are duplexed and therefore do not cause a system interruption when they fail.

INPUT's calculation of Product Availability found all products surveyed above the 99% level. Therefore, little variation by product could be determined with this method.

### **1. Non-Available Hours per Machine**

Exhibit II-4 displays a calculated number of non-available hours per year per machine which does reveal some significant differences between products.

The non-available hours were obtained by using the survey data of the number of non-routine service calls per machine per year, multiplied by the sum of the average response time, repair time and recovery time.



This data clearly identifies the IBM 3380 as the disk drive leader and the IBM 3480 as the tape drive leader.

The respondents satisfaction with product availability data also identifies the IBM 3380 as having the highest satisfaction and the lowest standard error of the mean for disk products. The IBM 3480 leads in the tape product area for the same reasons.

The final question put to respondents was how they would rate the products from an overall standpoint. The IBM 3380 disk device and the IBM 3480 tape device lead again with the highest ratings.

## C. Conclusion

A summary of the results of this study can be found in Exhibit II-5. For each appropriate question the best and worst disk and tape product was listed with its mean number in parenthesis.

In making this selection, the mean numbers were used with consideration given to median, range, standard error of the mean, and the number of users responding. Where appropriate, other factors were included such as taking into consideration the number installed of machine months with the IBM AS/400-20.

Overall, it is quite apparent the results of this study show that the IBM products come out the leaders, with the IBM 3380 disk and the IBM 3480 tape being the best in most cases. It is also very apparent that IBM has problems with its 9347 tape product, which came out the worst.

The worst disk product was more difficult to ascertain since the IBM AS/400-20, IBM 9335, and the DEC SA482 all were considered worst case in some areas. However, based upon the users rating and the MTBF, INPUT would have to rate the DEC SA482 as being the worst in the disk area.

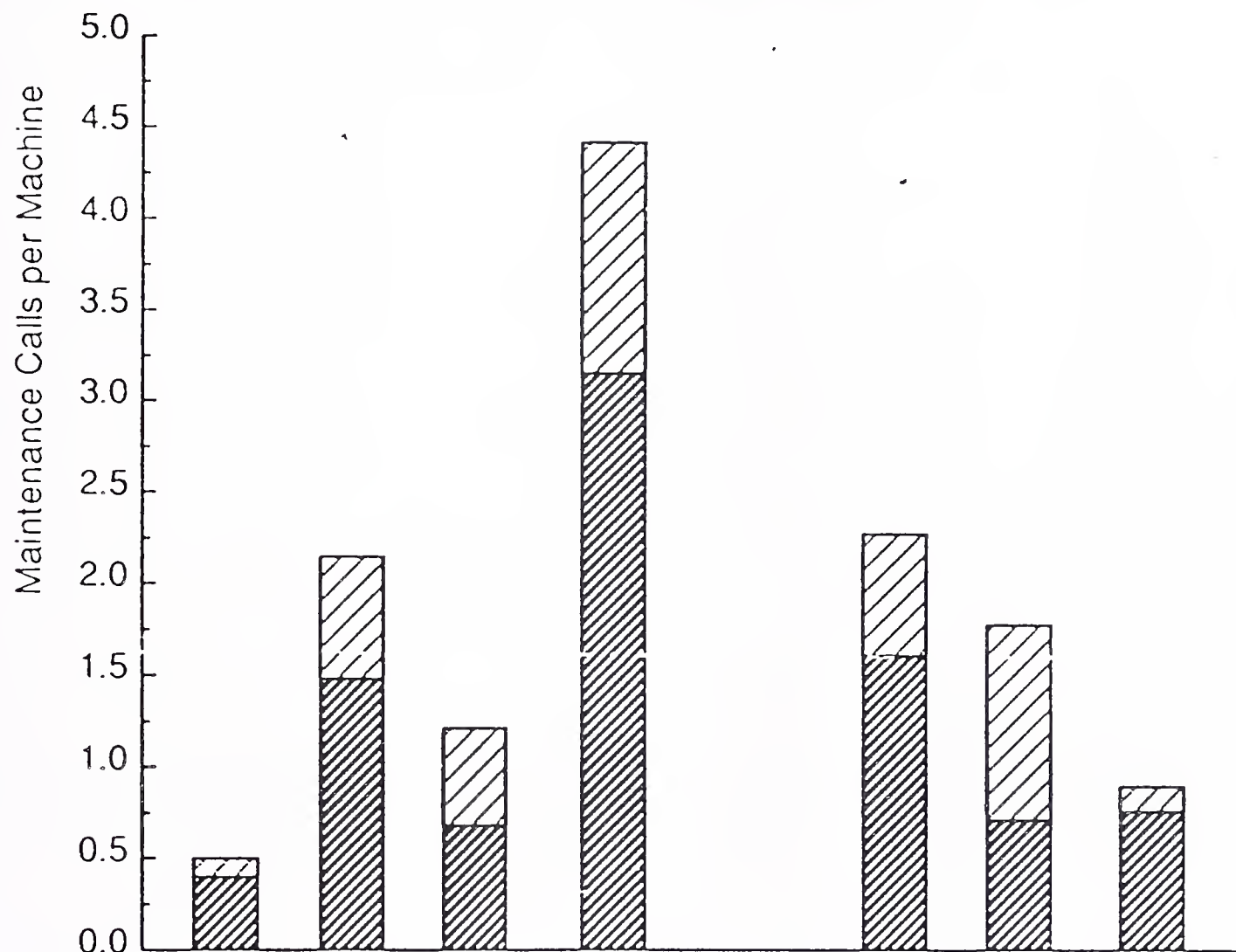
## EXHIBIT II-1

### CALCULATED MEAN TIME BETWEEN FAILURES (in Machine Months)

		<u>% No Failures</u>	<u>No Failures</u>	<u>Calculated MTBF</u>	<u>Number Responding</u>
<u>Disk</u>					
IBM	3380	29%	9	91.82	31
	9332	72%	21	19.71	29
	9335	48%	15	32.11	31
	AS/400-20	75%	21	30.63	28
DEC	RA 82	46%	15	63.57	33
	SA 482	10%	3	15.86	29
	RA 70	86%	25	79.61	29
<u>Tape</u>					
IBM	3422	35%	10	2.89	29
	9347	33%	9	1.42	27
	3480	17%	5	17.84	29
DEC	TU 81	35%	10	6.62	32



# DISK DRIVE MAINTENANCE CALLS NON-ROUTINE/ROUTINE PER MACHINE OVER THE LAST YEAR



Sample Size: 219    3380    9332    9335    AS/400-20    RA82    SA482    RA70

IBM    DEC



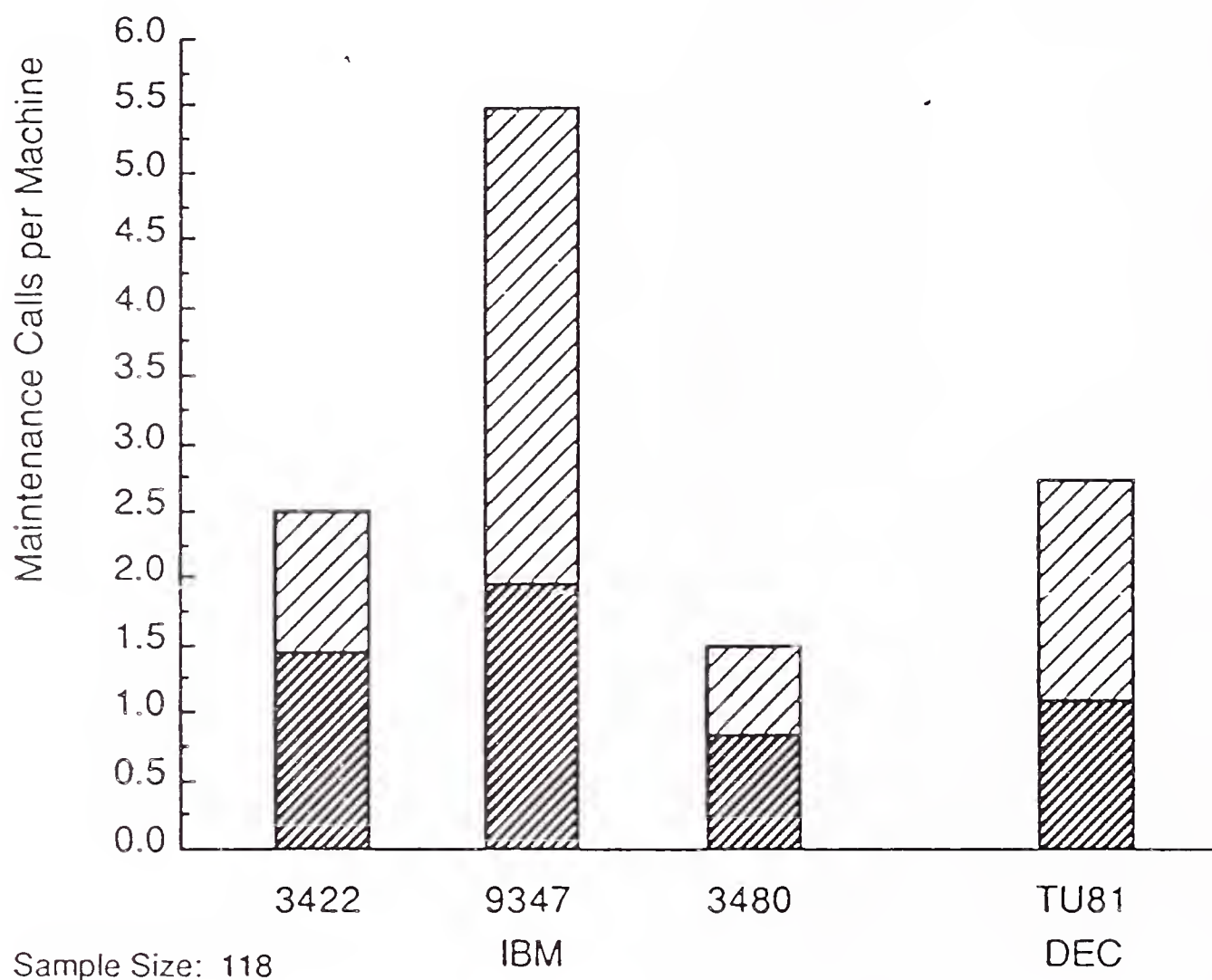
Maintenance Calls		ISM				SEO		
Non-Routine		0.1	0.67	0.54	1.26	0.67	1.07	0.13
Routine		0.4	1.48	0.69	3.16	1.61	0.71	0.77

EXHIBIT II-3

# TAPE DRIVE MAINTENANCE CALLS NON-ROUTINE/ROUTINE PER MACHINE OVER THE LAST YEAR



## Maintenance Calls

Non-Routine	1.05	3.53	0.65	1.63
Routine	1.44	1.97	0.85	1.1

EXHIBIT II-4  
NON-AVAILABLE HOURS PER YEAR

		<u>Non-Routine Svc. Calls per Mach./Yr.</u>	<u>Response Hours Mean</u>	<u>Repair Hours Mean</u>	<u>Recovery Hours Mean</u>	<u>Σ</u>	<u>Non- Available Hours</u>
<u>Disk</u>							
IBM	3380	0.10	1.50	3.54	5.03	10.07	1.02
	9332	0.67	1.54	8.91	6.25	16.70	11.19
	9335	0.54	1.51	5.63	11.30	18.44	9.96
	AS/400-20	1.26	4.88	3.39	10.94	19.21	24.20
DEC	RA 82	0.67	1.99	2.92	3.12	8.03	5.38
	SA 482	1.07	1.70	2.44	2.30	6.44	6.89
	RA 70	0.13	4.58	4.63	4.80	13.81	1.79
<u>Tape</u>							
IBM	3422	1.05	1.52	1.46	1.43	4.41	4.63
	9347	3.53	4.89	3.01	4.09	11.99	42.32
	3480	0.65	1.63	2.03	1.13	4.79	3.11
DEC	TU 81	1.63	4.47	7.57	2.96	15.00	24.45

## EXHIBIT II-5

### SUMMARY OF SURVEY RESULTS

	<u>Disk</u>		<u>Tape</u>	
	<u>Best</u>	<u>Worst</u>	<u>Best</u>	<u>Worst</u>
MTBF (Machine Mo.)	IBM 3380 (91.82)	DEC SA482 (15.86)	IBM 3480 (17.84)	IBM 9347 (1.42)
Non-Routine Calls (Yr.)	IBM 3380 (0.1)	IBM AS/400 -20 (1.26)*	IBM 3480 (0.65)	IBM 9347 (3.53)
Non-Available Hours	IBM 3380 (1.02)	IBM AS/400 -20 (24.2)*	IBM 3480 (3.11)	IBM 9347 (42.32)
Av. Response Time (Hrs.)	IBM 3380 (1.5)	IBM AS/400 -20 (4.88)*	IBM 3422 (1.52)	IBM 9347 (4.89) DEC TU81 (4.47)**
Av. Repair Time (Hrs.)	DEC SA482 (2.44)	IBM 9355 (5.63)***	IBM 3422 (1.46)	DEC TU81 (7.57)
Reported Recovery Time (Hrs.)	DEC SA482 (2.3)	IBM 9355 (11.3)	IBM 3480 (1.13)	IBM 9347 (4.09)
Satisfaction Reliability (1 = lowest 5 = highest)	IBM 3380 (4.7)	DEC SA482 (4.2)	IBM 3422 (4.6) IBM 3480 (4.7)**	IBM 9347 (4.0)
Satisfaction Availability (1 = lowest 5 = highest)	IBM 3380 (4.8)	DEC SA482 (4.3)	IBM 3480 (4.7)	IBM 9347 (4.0)
Overall Satisfaction (1 = lowest 5 = highest)	IBM 3380 (4.7)	DEC SA482 (4.1)	IBM 3480 (4.6)	IBM 9347 (3.8)

\* Small installed machine month history (i.e., 0.5 year average)

\*\* Both are included due to similarities

\*\*\* High number responding, lower standard error of mean, higher median

### **III Product Reliability**

#### **A. Calculated Mean Time Between Failures**

Product reliability is typically measured in terms of Mean Time Between Failures (MTBF) and in this study, INPUT has attempted to quantify this measurement in a consistent manner between the products being surveyed. The responses from users on MTBF, number of products installed, average time installed, and usage were all used to determine the calculated MTBF/machine across all users for each product. The formulas used are included in Appendix C. Exhibit III-1 presents the results of these calculations for the 11 products studied. (Also presented in Exhibit II-1.)

#### **B. Disk/Tape Drive Calculated MTBF**

A significant indication of the reliability is the percent of respondents who reported having no failures at all. The DEC RA70 had 86% of the respondents reporting no failures while the DEC SA482 had 10% of the respondents reporting no failures.

The mean product life for the DEC RA70 is only 0.7 years, so the confidence in the customers ability to state MTBF is somewhat low. the same is true for the IBM AS400-20, where the average installed age is only 0.5 years.

For disks, the IBM 3380 is clearly the leader, with a calculated MTBF of 91.82 months. The DEC SA482 has the lowest MTBF of 15.86 months.

In the tape sample, the IBM 3480 clearly leads with a MTBF of 17.84 months. the IBM 9347 has the lowest MTBF for tapes (1.42 months). It also has the lowest average age for tapes (i.e., 1.2 years) so the confidence in this data is not as great as for other tape products. Exhibits III-2 and III-3 provide a graphic display of the MTBF between the various disk and tape products studied.

#### **C. Service Calls per Machine per Year**

Another way to look at reliability is in terms of the number of service calls per machine per year. Users were asked for the number of calls they had experienced during the past year. This data was then adjusted for cases where the machines had been installed less than one year and for the number of machines installed in order to determine the service calls per machine. Exhibit III-4 displays data on total service calls.

The IBM 3380 clearly has the lowest number of disk calls per machine per year (i.e., 0.5) and has the lowest standard error of the mean (i.e., 0.13). The IBM AS/400-20 has the highest number of calls (i.e., 4.42) but the standard error is very high (i.e., 2.14) and as discussed earlier, the average length of time installed is only 0.5 year.



The IBM 3480 has the lowest number of tape calls (i.e., 1.5) and also the lowest standard error of the mean (i.e., 0.49). The IBM 9347 has the highest number of calls (i.e., 5.5) but it also has the highest standard error and the lowest age in terms of installed time.

#### **D. Routine Maintenance Calls Over the Last Year**

Exhibit III-5 displays data on the number of those calls that are routine type calls. Routine type calls are preventive maintenance and non-emergency type calls.

Routine maintenance calls follow the same pattern in terms of the IBM 3380 being the leader for disks and the IBM 3480 being the leader for tapes. An average of 69% of the maintenance calls for IBM drives were routine maintenance while 62% of the calls for DEC drives were routine.

#### **E. Disk/Tape Drive Maintenance Calls Non-Routine/Routine per Machine Over the Last Year**

Exhibit III-6 displays graphically the difference in calls between disk drives and the portion of the total calls that are non-routine and routine. The same type of information for tape drives is displayed in Exhibit III-7. An average of 45% of the calls for each IBM tape drive were routine maintenance, while 40% of the calls for DEC drives were routine. (Also presented in Exhibit II-2 and Exhibit II-3.)

#### **F. Systems Interruptions Due to Disk/Tape**

Exhibit III-8 presents the percent of respondents with system interruptions caused by tape or disk problems. The first column is the percent of the total sample who had systems interruptions due to disk/tape. The second column is the percentage of respondents who had no systems interruptions at all. The third column refers to the number of respondents who reported systems interruptions. The fourth column refers to the total number of respondents for that subsystem.

In the disk product category, if the AS/400-20 and RA70 are eliminated due to the small number of installed machine months, the IBM 9332 has the lowest percent and the DEC SA482 has the highest percent. For tapes, the IBM 3422 at 26.7% and the DEC TU81 at 28.1% are very close together and lead other tape products.

Exhibit III-8A presents the average percent of system interruptions due to disk/tape of the respondents who had system interruptions. The first column is the number of respondents who had system interruptions and said that 0% was due to disk or tape. The second column is the average, or mean, of the percentages reported due to disk/tape. For example, for the IBM 3380, the mean of 15.8% was calculated taking the 33 respondents who had systems interruptions, adding the percentages reported



due to disk, and dividing by 33. The third column is the range of percentages reports as being due to disk/tape. The fourth column is the standard error of the mean. The fifth column is the number of respondents who reported system interruptions.

In the disk area, the DEC RA82, with an average of 10.1%, reported the lowest percentage of interruptions due to the disk subsystem. The IBM 3422, at 5.1%, reported the lowest percent of interruptions due to the tape subsystem.

## **G. Customer Perception Maintenance Calls per Machine/Year**

Another method to measure reliability is to look at the customer perception of whether the maintenance calls on his equipment are below average, average, or excessive. The question probably provides a better indicator of how the customer feels about the number of calls than it does whether his inventory is below or above the average. This is because most customers do not have access to national average data by product.

Exhibit III-9 displays the respondents replies to this question and clearly indicates that the IBM 3380 leads by a wide margin for disks and the IBM 3422 leads for tape drives.

## **H. User Satisfaction with Reliability**

Respondents were asked to state their satisfaction with the reliability of the products by rating satisfaction on a scale of one to five, with five being the highest satisfaction.

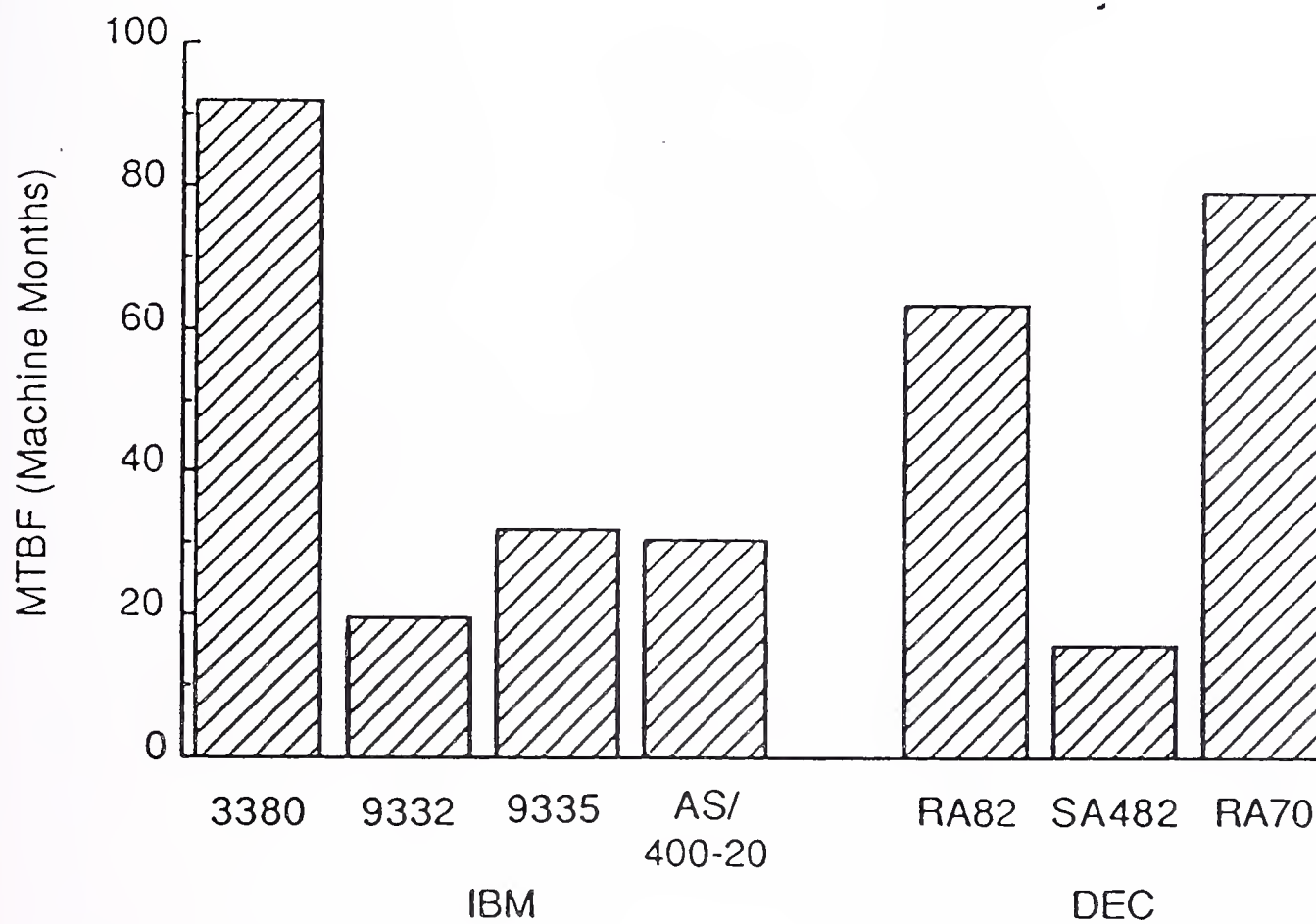
Exhibit III-10 provides a summary of the responses to user satisfaction with reliability. For disk products, the IBM 3380 and the DEC RA70 have the highest ratings and the lowest standard error of the mean. The RA70 however has a low average installed age of only 0.7 years. The IBM 3480 received the best overall rating for tapes, followed by the IBM 3422.

EXHIBIT III-1

CALCULATED MEAN TIME BETWEEN FAILURES  
(in Machine Months)

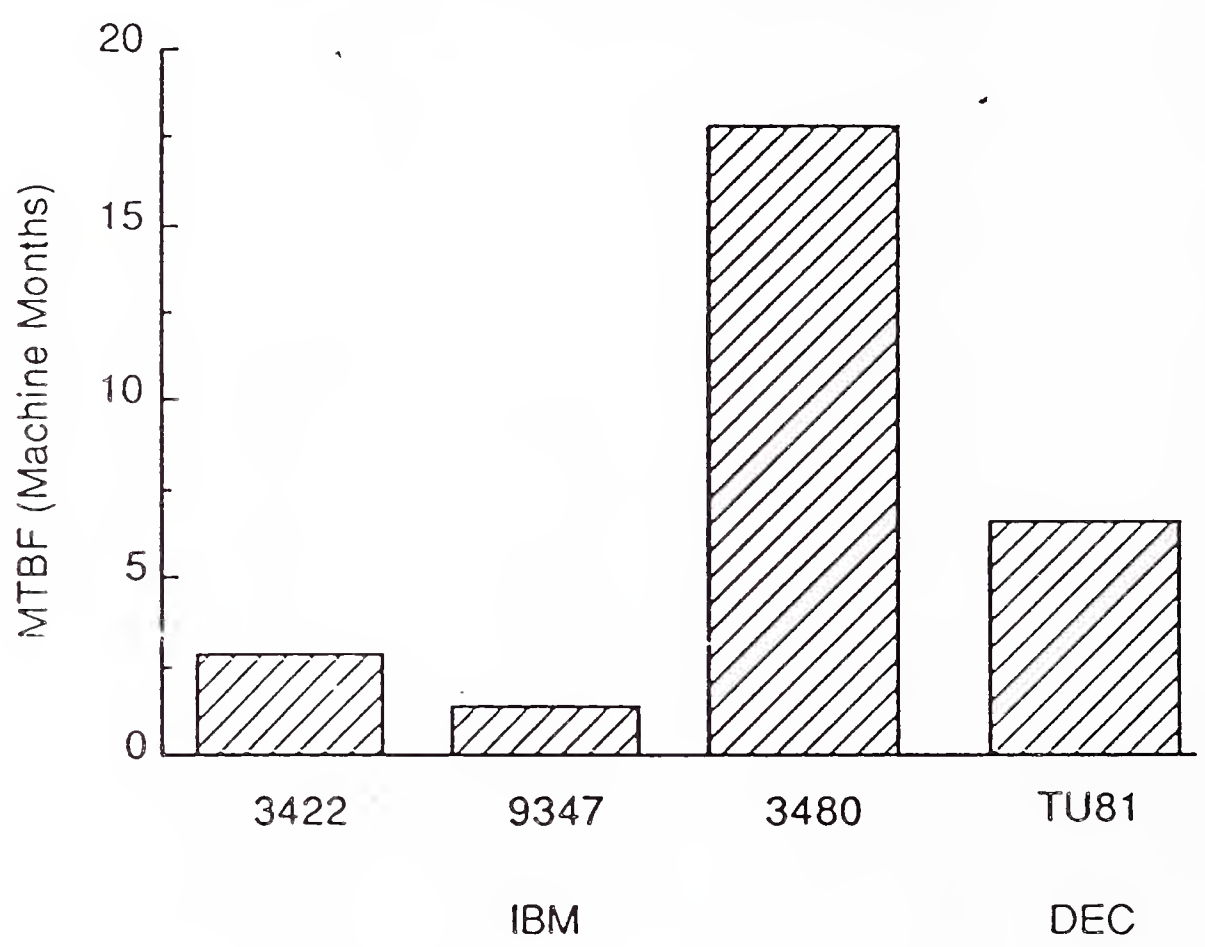
		<u>% No Failures</u>	<u>No Failures</u>	<u>Calculated MTBF</u>	<u>Number Responding</u>
<u>Disk</u>					
IBM	3380	29%	9	91.82	31
	9332	72%	21	19.71	29
	9335	48%	15	32.11	31
	AS/400-20	75%	21	30.63	28
DEC	RA 82	46%	15	63.57	33
	SA 482	10%	3	15.86	29
	RA 70	86%	25	79.61	29
<u>Tape</u>					
IBM	3422	35%	10	2.89	29
	9347	33%	9	1.42	27
	3480	17%	5	17.84	29
DEC	TU 81	35%	10	6.62	32

**DISK DRIVE  
CALCULATED MEAN TIME BETWEEN FAILURES  
(In Machine Months)**



Sample Size: 210

**TAPE DRIVE  
CALCULATED MEAN TIME BETWEEN FAILURES  
(in Machine Months)**



Sample Size: 117

EXHIBIT III-4  
SERVICE CALLS OVER THE LAST YEAR  
Per Machine

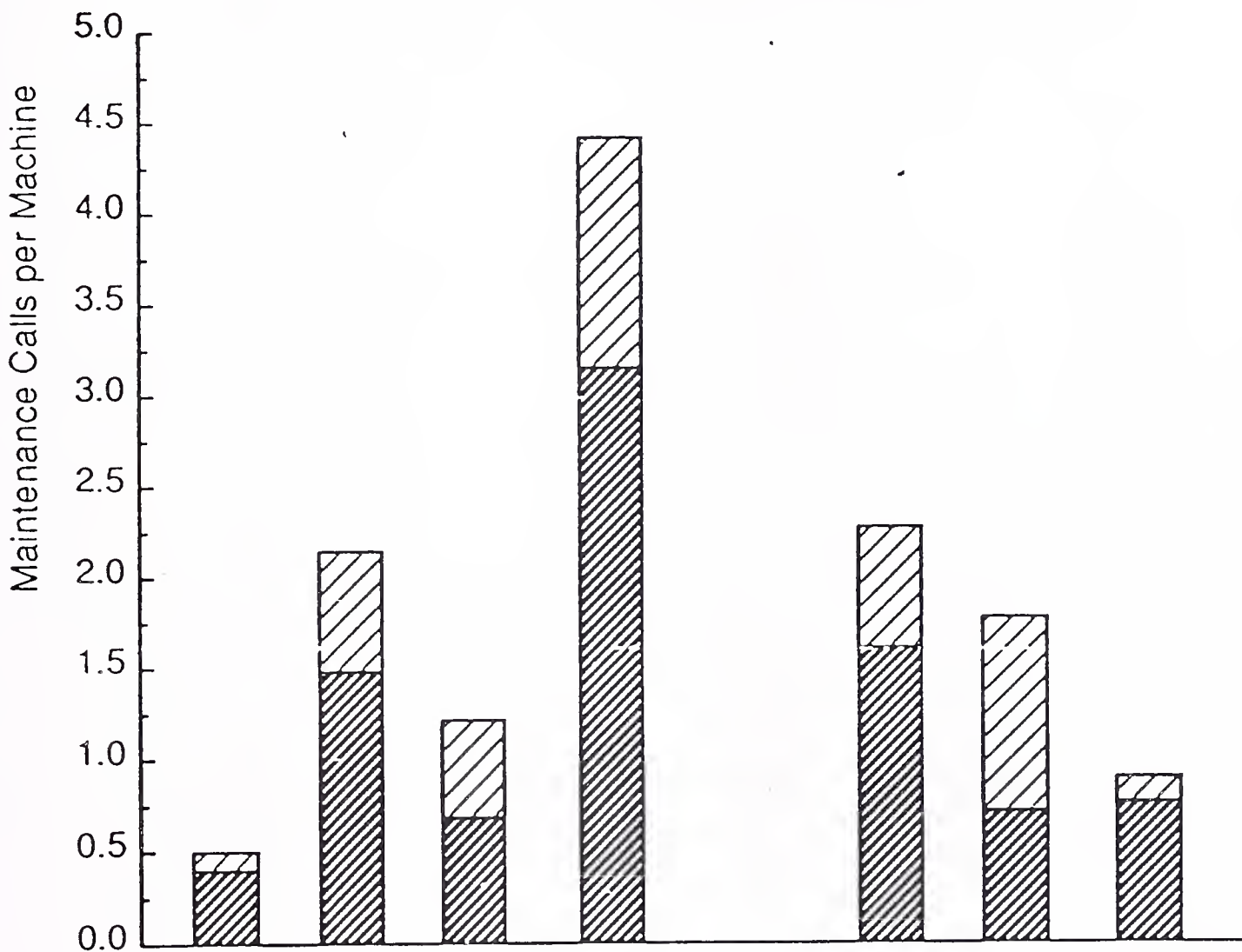
		<u>Mean</u>	<u>Median</u>	<u>Range</u>	<u>Std. Error of Mean</u>	<u>Number Responding</u>
<u>Disk</u>						
IBM	3380	0.50	0.17	0 - 2.89	0.13	32
	9332	2.15	0.29	0 - 26.00	0.90	30
	9335	1.23	0.50	0 - 6.67	0.34	30
	AS/400-20	4.42	1.67	0 - 60.00	2.14	30
DEC	RA 82	2.28	0.73	0 - 12.00	0.55	34
	SA 482	1.78	1.20	0 - 6.25	0.31	29
	RA 70	0.90	0.00	0 - 10.67	0.40	31
<u>Tape</u>						
IBM	3422	2.49	2.00	0 - 12.00	0.49	30
	9347	5.50	2.00	0 - 52.00	2.10	30
	3480	1.50	1.06	0 - 6.50	0.30	29
DEC	TU 81	2.73	1.00	0 - 12.00	0.60	31

EXHIBIT III-5  
ROUTINE MAINTENANCE CALLS OVER THE LAST YEAR  
Per Machine

		<u>Mean</u>	<u>Median</u>	<u>Range</u>	<u>Std. Error of Mean</u>	<u>Number Responding</u>
<u>Disk</u>						
IBM	3380	0.40	0.00	0 - 2.72	0.12	33
	9332	1.48	0.00	0 - 26.00	0.88	30
	9335	0.69	0.00	0 - 6.00	0.25	31
	AS/400-20	3.16	1.33	0 - 40.00	1.42	28
DEC	RA 82	1.61	0.33	0 - 12.00	0.47	34
	SA 482	0.71	0.29	0 - 6.00	0.22	32
	RA 70	0.77	0.00	0 - 8.00	0.34	31
<u>Tape</u>						
IBM	3422	1.44	0.20	0 - 12.00	0.50	29
	9347	1.97	0.00	0 - 52.00	1.79	29
	3480	0.85	0.00	0 - 5.00	0.26	30
DEC	TU 81	1.10	0.00	0 - 12.00	0.47	30



# DISK DRIVE MAINTENANCE CALLS NON-ROUTINE/ROUTINE PER MACHINE OVER THE LAST YEAR

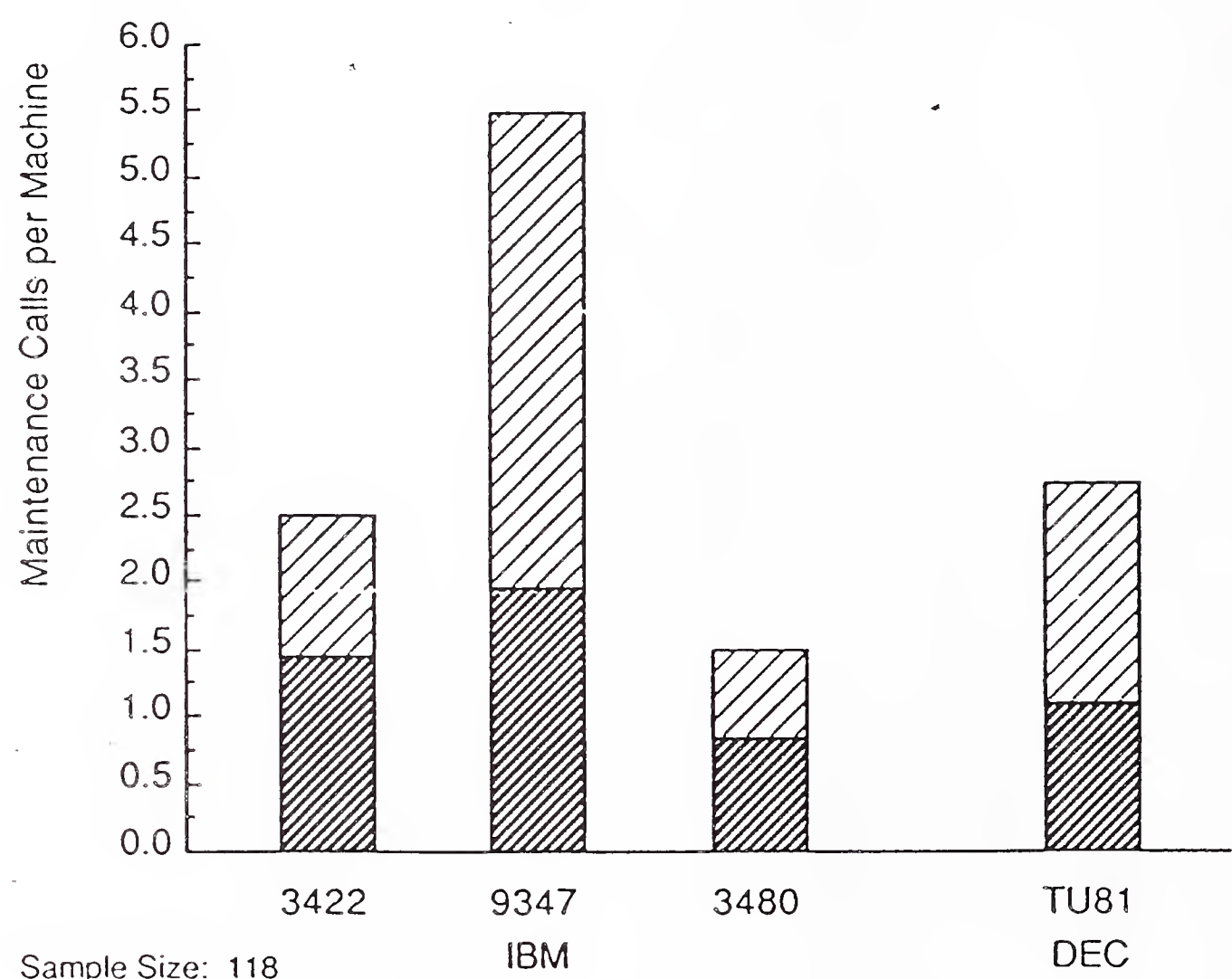


Sample Size: 219      3380      9332      9335      AS/      RA82      SA482      RA70  
400-20  
IBM      DEC

## Maintenance Calls



Non-Routine		0.1	0.67	0.54	1.26	0.67	1.07	0.13
Routine		0.4	1.48	0.69	3.16	1.61	0.71	0.77

TAPE DRIVE MAINTENANCE CALLS  
NON-ROUTINE/ROUTINE PER MACHINE  
OVER THE LAST YEAR



Sample Size: 118

Maintenance Calls

Non-Routine		1.05	3.53	0.65	1.63
Routine		1.44	1.97	0.85	1.1

## EXHIBIT III-8

PERCENT OF RESPONDENTS WITH SYSTEM INTERRUPTIONS  
DUE TO DISK/TAPE

		<u>% Respond. with System Interruptions due to Disk/Tape</u>	<u>% No System Interruptions</u>	<u># Respond. with System Interruptions</u>	<u>Number Responding</u>
<u>Disk</u>					
IBM	3380	60.5	13.20	33	38
	9332	30.0	20.00	24	30
	9335	51.6	22.60	24	31
	AS/400-20	16.7	40.00	18	30
DEC	RA 82	50.0	11.70	30	34
	SA 482	65.6	0.03	31	32
	RA 70	12.1	30.00	23	33
<u>Tape</u>					
IBM	3422	26.7	10.00	27	30
	9347	30.0	26.70	22	30
	3480	34.3	5.70	33	35
DEC	TU 81	28.1	3.00	31	32

EXHIBIT III-8A

SYSTEMS INTERRUPTIONS  
Percent Due to Disk/Tape

		# Respondents with None Due to Disk/Tape	Mean %	Range	Std. Error of Mean	Respond. with Interruptions
DISK						
IBM	3380	10	15.8	0 - 100	4.0	33
	9332	15	13.8	0 - 100	5.1	24
	9335	8	35.5	0 - 100	9.2	24
	AS400-20	13	13.2	0 - 100	7.6	18
DEC	RA82	13	10.1	0 - 100	4.1	30
	SA482	10	14.9	0 - 100	4.3	31
	RA70	19	7.4	0 - 100	4.6	23
TAPE						
IBM	3422	19	5.7	0 - 75	3.0	27
	9347	13	14.0	0 - 100	5.3	22
	3480	21	9.9	0 - 100	4.9	33
DEC	TU81	22	12.6	0 - 90	4.7	31

EXHIBIT III-9

CUSTOMER PERCEPTION  
MAINTENANCE CALLS PER MACHINE/YEAR  
NUMBER OF MENTIONS

		<u>Below Average</u>	<u>Average</u>	<u>Excessive</u>	<u>Number Responding</u>
<u>Disk</u>					
IBM	3380	30	7	-	37
	9332	15	10	4	29
	9335	21	7	2	30
	AS/400-20	14	12	2	28
DEC	RA 82	20	10	2	32
	SA 482	10	15	5	30
	RA 70	23	9	-	32
<u>Tape</u>					
IBM	3422	23	7	-	30
	9347	13	9	5	27
	3480	18	16	1	35
DEC	TU 81	18	11	2	31



EXHIBIT III-10  
USER SATISFACTION WITH RELIABILITY

		<u>Mean</u>	<u>Median</u>	<u>Range</u>	<u>Std. Error of Mean</u>	<u>Number Responding</u>
<u>Disk</u>						
IBM	3380	4.7	5.0	4 - 5	0.074	38
	9332	4.7	5.0	2 - 5	0.130	29
	9335	4.5	5.0	2 - 5	0.153	31
	AS/400-20	4.5	5.0	3 - 5	0.115	30
DEC	RA 82	4.5	5.0	3 - 5	0.105	34
	SA 482	4.2	4.0	2 - 5	0.158	32
	RA 70	4.8	5.0	3 - 5	0.081	33
<u>Tape</u>						
IBM	3422	4.6	5.0	3 - 5	0.102	30
	9347	4.0	4.5	1 - 5	0.220	30
	3480	4.7	5.0	3 - 5	0.090	35
DEC	TU 81	4.1	4.0	1 - 5	0.166	32

SCALE:

1 = Lowest Satisfaction  
5 = Highest Satisfaction

## **IV. Product Availability**

Availability is typically measured as follows:

$$\text{Availability \%} = \frac{\text{Customer Planned Use Time} - (\text{Response, Repair, and Recovery Time})}{\text{Customer Planned Use Time}}$$

System availability with the latest products typically runs 96% or higher for small and mid-range systems and 98% or higher for large systems. The availability of the units that make up the system therefore have a requirement for a much higher availability unless they are duplexed and therefore do not cause a system interruption when they fail.

INPUT has calculated availability consistent with the typical approach and consistent across all products being studied. The methodology for the calculation is described in Appendix D.

Exhibit IV-1 presents the calculated product availability using the typical approach and the results indicate very little difference between the different products.

### **A. Non-Available Hours per Year**

The key variables in determining availability are the number of non-routine calls per machine multiplied times the sum of the response time, the repair time, and the recovery time. Exhibit IV-2 utilizes the mean information for these items from the survey and displays the resulting non available hours per machine per year. These results do indicate a wide variance in non available hours between products. (Also presented in Exhibit II-4.)

For disk, the IBM 3380 clearly leads with slightly over one hour per year of non available hours. The IBM 3480 leads the tape products with only 3.1 hours of non availability.

### **B. Average Response Time**

Response time by product information is presented in Exhibit IV-3. IBM leads again in the disk area with the 3380 and in the tape area with the 3422.

### **C. Average Repair Time**

Repair time is displayed in Exhibit IV-4 and the DEC SA 482 leads with 2.44 hours for disk products. The IBM 3422 leads with 1.46 hours for the tape products.

## **D. Average Recovery Time**

Exhibit IV-5 displays the reported recovery time information. The IBM 9335 and the AS/400-20 have very long recovery times due to a very wide range of responses. The DEC SA 482 disk drive has the lowest recovery time at 2.3 hours and the IBM 3480 tape has the lowest recovery time at 1.13 hours.

## **E. Actual Up-Time**

Users were asked to provide an estimate of the actual up-time that the equipment was available for use each month in either days per month or hours per month. Most respondents provided days per month. This information is displayed in Exhibit IV-6 and it shows very little difference in the mean up-time between products.

## **F. Acceptable Up-time**

Exhibit IV-7 displays the information respondents view of how much up-time is acceptable for the various products. Here again the variance between the different products is very small.

## **G. Disk/Tape Up-Time**

The means of the acceptable and the actual are displayed in Exhibits IV-8 and IV-9. The surprise is that in some cases the mean actual time is higher than the mean acceptable time. In reviewing the data and calling back the respondents where this occurred, it was found that the respondent had counted time such as weekends when the equipment was available but they had no need for it.

## **H. User Satisfaction with Availability**

Respondents were asked to rate their satisfaction with the availability of the products surveyed. The results are displayed in Exhibit IV-10.

The IBM 3380 clearly achieves the highest satisfaction rating and the lowest standard error of the mean for the disk products. The IBM 3480 leads in the tape product area for the same reasons.

The DEC SA482 disk product and the IBM 9347 tape product achieved the lowest satisfaction.

## **I. User Overall Satisfaction with Product**

The final question put to the respondents was how they would rate the products from an overall standpoint. Exhibit IV-11 provides a summary of this information. The IBM 3380 disk device and the IBM 3480 tape device lead again with the highest rating and the lowest standard error of the mean.

The lowest overall satisfaction with disks was achieved by the DEC SA482, while the IBM 9347 achieved the lowest tape satisfaction.

EXHIBIT IV-1  
PRODUCT AVAILABILITY

Disk

IBM	3380	99.9%
	9332	99.9%
	9335	99.9%
	AS/400-20	99.9%
DEC	RA82	99.9%
	SA482	99.9%
	RA70	99.9%

Tape

IBM	3422	99.8%
	9347	99.3%
	3480	99.9%
DEC	TU81	99.8%

## EXHIBIT IV-2

## NON-AVAILABLE HOURS PER YEAR

		<u>Non-Routine Svc. Calls per Mach./Yr.</u>	<u>Response Hours Mean</u>	<u>Repair Hours Mean</u>	<u>Recovery Hours Mean</u>	<u>Σ</u>	<u>Non- Available Hours</u>
<u>Disk</u>							
IBM	3380	0.10	1.50	3.54	5.03	10.07	1.02
	9332	0.67	1.54	8.91	6.25	16.70	11.19
	9335	0.54	1.51	5.63	11.30	18.44	9.96
	AS/400-20	1.26	4.88	3.39	10.94	19.21	24.20
DEC	RA 82	0.67	1.99	2.92	3.12	8.03	5.38
	SA 482	1.07	1.70	2.44	2.30	6.44	6.89
	RA 70	0.13	4.58	4.63	4.80	13.81	1.79
<u>Tape</u>							
IBM	3422	1.05	1.52	1.46	1.43	4.41	4.63
	9347	3.53	4.89	3.01	4.09	11.99	42.32
	3480	0.65	1.63	2.03	1.13	4.79	3.11
DEC	TU 81	1.63	4.47	7.57	2.96	15.00	24.45



EXHIBIT IV-3  
AVERAGE RESPONSE TIME (Hours)

		<u>Mean</u>	<u>Median</u>	<u>Range</u>	Std. Error of Mean	<u>Number Responding</u>
<u>Disk</u>						
IBM	3380	1.50	1.00	0.25 - 4	0.18	33
	9332	1.54	1.25	0.50 - 4	0.26	12
	9335	1.51	1.00	0.50 - 4	0.17	24
	AS/400-20	4.88	2.00	0.50 - 24	1.99	12
DEC	RA 82	1.99	2.00	0.17 - 5	0.23	28
	SA 482	1.70	1.50	0.17 - 4	0.19	29
	RA 70	4.58	3.00	1.00 - 24	1.70	13
<u>Tape</u>						
IBM	3422	1.52	1.00	0.50 - 5	0.21	25
	9347	4.89	2.00	0.25 - 48	2.25	21
	3480	1.63	2.00	0.25 - 4	0.18	28
DEC	TU 81	4.47	3.00	0.25 - 24	1.09	23

EXHIBIT IV-4  
AVERAGE REPAIR TIME (Hours)

		<u>Mean</u>	<u>Median</u>	<u>Range</u>	<u>Std. Error of Mean</u>	<u>Number Responding</u>
<u>Disk</u>						
IBM	3380	3.54	2.0	0.50 - 24	1.04	30
	9332	8.91	2.0	0.50 - 60	5.24	11
	9335	5.63	5.0	0.50 - 24	1.31	23
	AS/400-20	3.39	2.0	0.15 - 24	1.89	12
DEC	RA 82	2.92	2.0	0.75 - 16	0.55	28
	SA 482	2.44	2.0	0.50 - 6	0.25	32
	RA 70	4.63	2.0	0.50 - 24	1.98	12
<u>Tape</u>						
IBM	3422	1.46	1.0	0.50 - 4	0.20	24
	9347	3.01	1.0	0.50 - 24	1.23	19
	3480	2.03	2.0	0.33 - 8	0.30	28
DEC	TU 81	7.57	2.0	0.50 - 48	2.98	23

EXHIBIT IV-5  
AVERAGE RECOVERY TIME (Hours)

		<u>Mean</u>	<u>Median</u>	<u>Range</u>	<u>Std. Error of Mean</u>	<u>Number Responding</u>
<u>Disk</u>						
IBM	3380	5.03	2.0	0.25 - 48	1.83	28
	9332	6.25	2.0	0.50 - 24	3.01	8
	9335	11.30	3.0	0.50 - 72	4.14	20
	AS/400-20	10.94	2.5	0.75 - 48	5.99	8
DEC	RA 82	3.12	2.0	0.50 - 12	0.56	27
	SA 482	2.30	2.0	0.50 - 5	0.30	26
	RA 70	4.80	2.0	0.25 - 24	2.52	9
<u>Tape</u>						
IBM	3422	1.43	1.0	0.50 - 3	0.23	14
	9347	4.09	2.0	0.25 - 24	1.63	14
	3480	1.13	1.0	0.25 - 3	0.15	21
DEC	TU 81	2.96	1.0	0.25 - 24	1.78	13

EXHIBIT IV-6  
ACTUAL UP-TIME  
(Days per Month)

		<u>Mean</u>	<u>Median</u>	<u>Range</u>	<u>Std. Error of Mean</u>	<u>Number Responding</u>
<u>Disk</u>						
IBM	3380	27.7	30.0	12 - 31	0.792	33
	9332	26.9	30.0	20 - 31	0.825	29
	9335	28.0	30.0	20 - 31	0.716	27
	AS/400-20	27.7	30.0	20 - 30	0.716	29
DEC	RA 82	29.2	30.0	20 - 31	0.347	32
	SA 482	28.9	29.9	22 - 30	0.347	32
	RA 70	29.6	30.0	22 - 31	0.352	31
<u>Tape</u>						
IBM	3422	27.3	30.0	20 - 31	0.781	28
	9347	26.4	30.0	20 - 30	0.813	30
	3480	27.6	30.0	20 - 31	0.686	31
DEC	TU 81	29.3	30.0	20 - 31	0.385	29

EXHIBIT IV-7  
ACCEPTABLE UP-TIME  
(Days per Month)

		<u>Mean</u>	<u>Median</u>	<u>Range</u>	<u>Std. Error of Mean</u>	<u>Number Responding</u>
<u>Disk</u>						
IBM	3380	29.4	30.0	21 - 31	0.035	31
	9332	28.3	30.0	20 - 31	0.689	25
	9335	27.3	29.0	20 - 31	0.671	27
	AS/400-20	27.5	30.0	20 - 30	0.775	24
DEC	RA 82	29.3	30.0	20 - 31	0.329	31
	SA 482	29.0	30.0	20 - 30	0.383	31
	RA 70	29.7	30.0	22 - 31	0.293	30
<u>Tape</u>						
IBM	3422	26.6	29.5	20 - 31	0.836	26
	9347	25.9	29.0	20 - 30	0.884	28
	3480	28.6	30.0	18 - 31	0.556	31
DEC	TU 81	28.9	30.0	19 - 31	0.491	31

EXHIBIT IV-8  
TAPE UP-TIME

<u>Tape</u>		<u>Days/Month</u>		<u>% Achieved</u>
		<u>Acceptable</u>	<u>Actual</u>	
IBM	3422	26.6	27.3	102.6
	9347	25.9	26.4	101.9
	3480	28.6	27.6	96.5
DEC	TU 81	28.9	29.3	101.4



EXHIBIT IV-9  
DISK UP-TIME

<u>Disk</u>		<u>Days/Month</u>		<u>% Achieved</u>
		<u>Acceptable</u>	<u>Actual</u>	
IBM	3380	29.4	27.7	94.2
	9332	28.3	26.9	95.1
	9335	27.3	28.0	102.6
	AS/400-20	27.5	27.6	100.40
DEC	RA 82	29.3	29.2	99.7
	SA 482	29.0	28.9	99.7
	RA 70	29.7	29.6	99.7

EXHIBIT IV-10  
USER SATISFACTION WITH AVAILABILITY

		<u>Mean</u>	<u>Median</u>	<u>Range</u>	<u>Std. Error of Mean</u>	<u>Number Responding</u>
<u>Disk</u>						
IBM	3380	4.8	5.0	4 - 5	0.070	38
	9332	4.4	5.0	1 - 5	0.184	30
	9335	4.6	5.0	3 - 5	0.110	31
	AS/400-20	4.6	5.0	3 - 5	0.102	30
DEC	RA 82	4.5	5.0	2 - 5	0.128	34
	SA 482	4.3	4.0	2 - 5	0.156	32
	RA 70	4.8	5.0	3 - 5	0.087	33
<u>Tape</u>						
IBM	3422	4.5	5.0	2 - 5	0.142	30
	9347	4.0	4.0	2 - 5	0.186	30
	3480	4.7	5.0	3 - 5	0.091	35
DEC	TU 81	4.4	5.0	2 - 5	0.164	31

SCALE:

1 = Lowest Satisfaction  
5 = Highest Satisfaction

EXHIBIT IV-11  
USER OVERALL SATISFACTION WITH PRODUCT

		<u>Mean</u>	<u>Median</u>	<u>Range</u>	<u>Std. Error of Mean</u>	<u>Number Responding</u>
<u>Disk</u>						
IBM	3380	4.7	5.0	4 - 5	0.074	38
	9332	4.6	5.0	2 - 5	0.157	30
	9335	4.5	5.0	3 - 5	0.130	31
	AS/400-20	4.6	5.0	3 - 5	0.105	29
DEC	RA 82	4.4	4.0	3 - 5	0.119	34
	SA 482	4.1	4.0	2 - 5	0.168	32
	RA 70	4.5	5.0	2 - 5	0.138	33
<u>Tape</u>						
IBM	3422	4.5	5.0	2 - 5	0.124	30
	9347	3.8	4.0	1 - 5	0.209	29
	3480	4.6	5.0	3 - 5	0.092	35
DEC	TU 81	4.0	4.0	1 - 5	0.174	32

SCALE:

1 = Lowest Satisfaction  
5 = Highest Satisfaction

## APPENDIX A

Questionnaire  
Revision 5.

Good morning (afternoon), my name is \_\_\_\_\_. I'm calling from INPUT, an international research and planning firm. We are currently involved in the study of disk and tape subsystems and would like to discuss this subject with you. Do you have about fifteen minutes now to answer a few questions, or may I make an appointment to speak with you at a more convenient time? Your responses will be kept completely confidential and we are seeking no proprietary information.

1. Do you have any \_\_\_\_\_ (insert make/model number of disk / tape device from list with a quantity of 1 or more, except for the IBM 3380 which must have a quantity of 10) installed at this location? (within your realm of responsibility)

Yes \_\_\_\_\_ No \_\_\_\_\_

If no, go on to the next model number from the respondent list that is also on the model list and repeat the above questions.

- 1a. If yes, what is the quantity? Qty. \_\_\_\_\_

(To qualify the respondent must have at least a quantity of 1 or more of any of the disk or tape devices on the list, except the IBM 3380 which must have a quantity of 10. If this criteria is not met, thank the respondent for his/her time, fill in the cover sheet, and terminate call.)

2. What are the primary CPUs to which this equipment is connected?

<u>Manufacturer</u>	<u>Model No.</u>
(1) _____	_____
(2) _____	_____
(3) _____	_____
(4) _____	_____
(5) _____	_____

3. What applications are running on these CPUs?

Manufacturing	(01)	_____	Accounting (AR,AP,GL)	(13)	_____
Transportation	(02)	_____	Engineering/Scientific	(14)	_____
Utilities	(03)	_____	Office Systems (word processing,		
Telecommunications	(04)	_____	E-mail, calendar, etc.)	(15)	_____
Distribution	(05)	_____	Other	(16)	_____
Banking/Finance	(06)	_____			
Insurance	(07)	_____			
Medical	(08)	_____			
Education (schools)	(09)	_____			
Services (lawyers,					
accountants, etc.)	(10)	_____			
Federal Government	(11)	_____			
State/Local Government	(12)	_____			

For the next series of questions, we are going to ask only about \_\_\_\_\_  
(Insert the make/model number of the qualified disk or tape device (circle one).)

4a. What is the approximate age of this device? \_\_\_\_\_ yrs.

(Or if there are more than one and they were installed in various years, fill in the following.

(\_1) Qty. \_\_\_\_\_ Yrs. \_\_\_\_\_.

(\_2) Qty. \_\_\_\_\_ Yrs. \_\_\_\_\_.

(\_3) Qty. \_\_\_\_\_ Yrs. \_\_\_\_\_.

4b. Approximately how many hours per day is this equipment in use?

\_\_\_\_\_ hours.

4c. How many days per week? \_\_\_\_\_ days.

5a. What do you believe is an acceptable amount of time between failures for this equipment?

\_\_\_\_\_ weeks \_\_\_\_\_ years

\_\_\_\_\_ months

5b. What do you believe is acceptable available "up-time" for this equipment?

\_\_\_\_\_ days per month \_\_\_\_\_ hours per year

(We define "up-time" as time when maintenance is not being performed or when the disk / tape device is operating.)

6a. How many times per month does this equipment fail, or what is the mean time between failures? (Interviewer fill in one, according to the response.)

\_\_\_\_\_ times per month

\_\_\_\_\_ times per year

MTBF: \_\_\_\_\_ months

MTBF: \_\_\_\_\_ years

6b. What is the actual amount of time the equipment is available for use, or up-time?

\_\_\_\_\_ days per month

\_\_\_\_\_ hours per month

(We define "up-time" as time when maintenance is not being performed or when the disk / tape device is operating.)



6c. When there is a disk / tape (circle one) failure, what is the average response time, in hours?

(Response time is the time that it takes for a service person to arrive after a service call has been placed.)

\_\_\_\_\_ hours

6d. What is the average repair time?

\_\_\_\_\_ hours

6e. What is the average recovery time?

\_\_\_\_\_ hours

(Recovery time is the time between the completed repair/maintenance and actual time disk / tape device is available for application use; when you can start running applications again.)

7a. How many times over the last year have you had a service representative in for this disk / tape device (circle one)?

\_\_\_\_\_ times over the last year

7b. Of those calls, how many were routine maintenance?

\_\_\_\_\_ qty.

7c. Would you say your number of calls per machine per year is below average, average, or excessive?

below average \_\_\_\_\_(1)

average \_\_\_\_\_(2)

or excessive \_\_\_\_\_(3)

no response/don't know \_\_\_\_\_(9)

8a. Approximately how many system interruptions do you experience on a yearly basis?  
\_\_\_\_\_ per year

8b. What percent of these system interruptions are due to problems with the disk / tape (circle one) device?

\_\_\_\_\_ %

I'd like to go back now to the \_\_\_\_\_ (insert model number) disk / tape device (circle one) for a minute.

9a. How satisfied are you with the availability of the disk / tape device (circle one), on a scale of 1 - 5, where 1 = very poor and 5 = excellent?

1      2      3      4      5      (0 = Don't know)

9b. How satisfied are you with the reliability of the disk / tape device (circle one), on a scale of 1 - 5, where 1 = very poor and 5 = excellent?

1      2      3      4      5      (0 = Don't know)

9c. Overall, how would you rate this device on a scale of 1 - 5 where 1 = very poor and 5 = excellent?

1      2      3      4      5      (0 = Don't know)

#### INTERVIEWER, PLEASE NOTE:

If the respondent has more than one qualifiable disk or tape device, continue the interview with a new questionnaire and attach to this questionnaire.

When you have covered all of the qualifiable devices , thank the respondent for his/her time and get cover information for the study.

Cover information is filled in only for the first questionnaire per company, successive questionnaires have only a new control number and the company name filled in on the cover sheet.

## APPENDIX B

### DEFINITIONS

**MEAN** - The value obtained by adding all the measurements and dividing by the number of measurements.

**MEAN TIME BETWEEN FAILURES (MTBF)** - The elapsed time between failures on a device or a system.

**MEAN TIME TO RESPOND (Response Time)** - The elapsed time between the user placement of a service call and the arrival at the user's location of a field engineer.

**MEDIAN** - Middle measurements in a set of measurements when the measurements are arranged in ascending order.

**RANGE** - The smallest and the largest answer given by the users.

**RECOVERY TIME** - The time between the completed repair/maintenance and the actual time the disk/tape device is available for application use.

**ROUTINE MAINTENANCE** - Preventive maintenance and non-emergency type maintenance.

**STANDARD DEVIATION** - The positive square root of the variance.

**STANDARD ERROR (of the mean)** - The standard deviation (SD) of the sample divided by the square root of the sample size.

**VARIANCE** - A measure of dispersion that takes into consideration the difference between each value in a data set and the mean of the group.

## APPENDIX C

### Calculated Mean Time Between Failures (MTBF)

#### For each respondent:

1. Calculate Total Machine Months Installed
  - Product Inventory X Average Months Installed
2. Adjusted Total Machine Months for Shifts of Use
  - Calculate Hours of Use per Week
    - If Question 4B is
      - 0 - 8 hours - assume 8 hours
      - 8 - 16 hours - assume 16 hours
      - 16 - 24 hours - assume 24 hours
    - Multiply # hours X # days per week (Question 4C)
  - Adjusted Total Machine Months
    - Total Machine Months X Hours of Use per Week / 168
3. Mean Time Between Failures (MTBF) (Months/Machine)
  - Determine MTBF for total subsystem (Question 6A)
  - Divide subsystem MTBF by Quantity Installed (Question 1A)
4. Number of Failures
  - Divide Adjusted Total Machines Months by the MTBF per Machine for each respondent

#### For each product type:

5. Calculate MTBF Across Total SAMPLE
  - A.  $\Sigma \text{ \# Failures per Respondent} = \text{Total Failures}$
  - B.  $\Sigma \text{ \# Adjusted Total Machine Months per Respondent} = \text{Total Machine Months}$
  - C.  $\text{MTBF} = \text{Total Machine Months} / \text{Total Failures}$

## APPENDIX D

### Calculated Availability Percentage

#### For each respondent:

1. Calculate Total Required Hours
  - Adjusted Total Machine Months X 720 (hours)
2. Calculate Available Hours
  - Total Required Hours - [(Response Time + Repair Time + Recovery Time) X # Failures per Respondent]
3. Availability % = Available Hours / Total Required Hours

#### For each product type:

4. Calculate % Availability per Product
  - A.  $\Sigma$  Total Required Hours per Respondent
  - B.  $\Sigma$  Available Hours per Respondent
  - C. Availability % per Product =  $\Sigma$  Available Hours /  $\Sigma$  Required Hours

## APPENDIX E

The following is the detail output from a PC program called ABstat™ that INPUT used in the statistical analysis of the answers to the 355 survey questionnaires included in this report.

Attached are details on the following questions:

- 4a. Average Age Calculated
- 5b. Acceptable Up-Time
- 6b. Actual Up-Time
- 6c. Response Time
- 6d. Repair Time
- 6e. Recovery Time
- 7a. Service Calls
- 7b. Routine Calls
- 8a. Systems Interruptions
- 8b. Systems Interruptions due to Disk/Tape
- 9a. Availability Satisfaction
- 9b. Reliability Satisfaction
- 9c. Overall Satisfaction

Each question has two sections of information on each product. One is the descriptive statistics and the other being frequencies and Z scores. At the top of each page you will find a Selection statement.

- "Selection: [4] = XXXX": States each product described in the following order:

3380 =	IBM 3380
9332 =	IBM 9332
9335 =	IBM 9335
40020 =	IBM AS/400-20
82 =	DEC RA 82
482 =	DEC SA 482
70 =	DEC RA 70
3422 =	IBM 3422
9347 =	IBM 9347
3480 =	IBM 3480
81 =	DEC TU 81



The descriptive statistics include the following:

- Valid Cases "XX": Where XX = number of valid respondents' answers included in the analysis.
- Mean, Median, Range (Minimum - Maximum), Standard Error of Mean: Terms used as input to exhibits, and defined in Appendix B, Definitions.
- The frequencies distribution section for each product/answer specified above is included and states how many times a value was given as the answer and the percent it represents of all answers to a question. Z scores were not used.

We have included this detail data to allow you to better analyze the summary exhibits included in this report.



# About INPUT

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